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Application of Evaluation Lines in Project Planning and Control

Miklós Hajdu^{*}, Gabriella Szenik, Gábor Bardócz*Ybl Miklós Faculty of Architecture and Civil Engineering SZIU, Budapest H-1146, Hungary*

Abstract

The efficient display of project schedules and the comparison between the plans and the actual data have been key areas of project management since the appearance of planning techniques. Various graphic techniques exist for displaying the project data, among which the most widespread is the Gantt chart, which is associated with Henry Gantt. The Gantt chart has gone through great development in the past decades: the logic-Gantt, which also contains the logical relationships, has appeared; furthermore, the available project planning applications provide several possibilities for the efficient display of the schedules and for the comparison of different plan versions and the planned and actual conditions. In this paper, a new graphic system is introduced, which makes the overview of large-scale projects much faster. This new system is called the system of evaluation lines. Its development has been inspired by the concept of the progress line, which is already present in project planning systems. In this sense, the progress line can be considered as a type of evaluation line. In the paper, the definition of the evaluation line is given and the evaluation lines are grouped according to their common characteristics. Then some, more interesting examples are shown. The paper redefines the concept of the progress lines, and sheds light on the disadvantages of the former solutions.

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1. Historic Overview - Scheduling Methods from the 19th Century till Today

The Gantt chart and its various versions are considered to be the most widespread technique in project planning even today. The original method was developed more than a hundred years ago, in 1903 (Gantt,

^{*} Corresponding author. Tel.: +36 309604005; fax: +36 12521278.
E-mail address: miklos.hajdu63@gmail.com.

1903). Despite the fact that project planners have been constantly striving for working out new techniques for the display of project plans, the Gantt chart is still the most popular due to its simplicity and manageability.

In order to be true to history, Adamieccki's Harmonogram has to be mentioned, which was invented in 1896, but it was published only in 1931 (Adamiecki, 1931). Owing to the fact that this technique preserved the logical dependencies between the activities, it could be considered the forerunner of today's modern network planning techniques.

Comprehending and managing Gantt charts containing thousands of activities could be very difficult. One of the reasons for this is that the logical relationships between the activities are not preserved; consequently, the entire plan has to be rethought when changes are needed. This problem was solved by the development of network planning techniques, where the mathematical models behind the methods allow the logical dependencies between the tasks to be preserved. Network plans appeared in the time of the Cold War. First they were used in the military, but they quickly gained legitimacy in the civilian life as well. The most well-known methods are the CPM, PERT and the MPM (PDM) technique, which could be considered to be a European invention. Today's project management applications are mainly based on them. However, no matter what the underlying model is, the most common way of displaying the schedule is the Gantt chart that also indicates the precedence relationships between the activities.

However, the quick development of the mathematical planning models was not followed by the development of graphic ways of depiction. The most widespread visual tools for displaying project plans are still the Gantt chart and its variations (showing logical dependencies, floats etc.). Still in case of large-scale projects, when we would like to quickly look over the plan, understand it and see the connections, having only bars representing the activities is not enough. For example, progress lines are excellent tools for the tracking of the project, to survey the progress of the tasks. This has given the idea for extending and applying the method to show the connection between the time and cost of the planning and realization. This new method was introduced by Hajdu in 2010 (Hajdu, 2010); he called it the system of evaluation lines. According to this, progress lines constitute a small group within the huge family of evaluation lines.

The system of evaluation lines has been developed by a research group at the Department of Construction Management at Szent István University's Ybl Miklós Faculty of Architecture and Civil Engineering.

2. Progress Lines

The progress line method served as a basis for our research when the development of the system of evaluation lines started. Before introducing the system of evaluation lines, let's see how progress lines, which can be found in MS Project (Szentirmai, 2011) and Primavera (Harris, 2010), can aid the work of project planners.

In both cases, progress lines are drawn in the Gantt chart view. With their help it could be determined whether the given task is ahead or behind schedule.

In the P6 version of Primavera, 4 different evaluation lines can be applied:

- to indicate the difference between the baseline start and scheduled start of the tasks,
- to indicate the difference between the baseline finish and scheduled finish of the tasks,
- to show the percentage of completion of activities,
- to show the remaining duration of activities.

In MS Project the progress of the activities can be displayed based on the percentage of completion.

Based on the above, it could be concluded that the progress line method can only be used in the tracking phase of the project, after surveying the activities and updating the schedule. Furthermore, solely

time-type data can be analyzed. Current applications do not allow project planners to display their plans with visual tools and analyze them in the scheduling phase of the project. Moreover, they are not suitable for the graphic display of cost-type and resource-type data.

3. The System of Evaluation Lines

3.1. The Structure of the System of Evaluation Lines, the Classification of Evaluation Lines

When creating the system of evaluation lines, the basic idea behind the progress line functions have been taken into account. After analyzing their advantages and disadvantages and defining the goals of the system, the classification of the evaluation lines could begin.

The following objectives have been set when developing the system of evaluation lines:

- To allow easy evaluation in the Gantt Chart View, so that those evaluating the plans do not have to switch between views and evaluate the connections between them as well.
- To allow analysis of the relationships between project data. If the information connected to the schedule, cost and resource plans could be displayed in one view, the links between them may become clearer.
- To facilitate quick evaluation. The large number of various views offered by project planning applications makes the evaluation of the plans difficult.
- To allow easy use for everyday people without special knowledge. Consequently, it should not be the user's task to process information, they ought to be provided with project data that are processed according to a given methodology and visually displayed for them.

Now, after summarizing our aims, let's see what groups are worth being defined. It is expedient to define the main classes based on the fundamental parts of the project plan:

- evaluation lines defined based on time-type data: visual display of date or duration-type information. In this case, date fields can be simply marked on the timescale, or durations can be plotted with respect to a base point (usually day 0).
- evaluation lines defined based on cost-type data,
- evaluation lines defined based on resource-type data.

Within the main groups further subgroups can be defined depending on the type of data the evaluation line indicates:

- Display of activity information with the help of simple or calculated data.
- Evaluation lines suitable for analyzing either tasks on the lowest level of the Work Breakdown Structure or summary tasks.
- Comparison of data related to a given plan version or of data belonging to different plan versions.
- Evaluation lines applicable in the planning or tracking phases of the project.

3.2. Revealing the Shortcomings of Planning

One way to show the shortcomings of planning is to examine the floats of the activities. However, this does not always reveal the real problems with the plan. Having a look at the relationships between the early and late finishes of the tasks provides more opportunities for analysis. (Hajdu, 2010, Szenik, 2011). The schedule for two sections of a sewage system construction project can be seen on Figure 1.

Here two evaluation lines are drawn in the Gantt chart view: the red continuous line indicates the early finishes of the activities, while the late finishes of the tasks are marked by the green dashed line. Just after one glance, it could be noted that, in case of some tasks, the difference between the early and late finishes is significant.

In this instance, if the same task could be performed simultaneously in different sections, the logical dependencies are properly defined. However, if the same activity can only be performed in one section at a time, then further relationships need to be defined. Figure 2 shows the result of the corrections. Owing to the new links, for example, a Finish-to-Start between the ‘Pipe laying’ of Section 2 and 3, the late finishes have got closer to the early finishes.

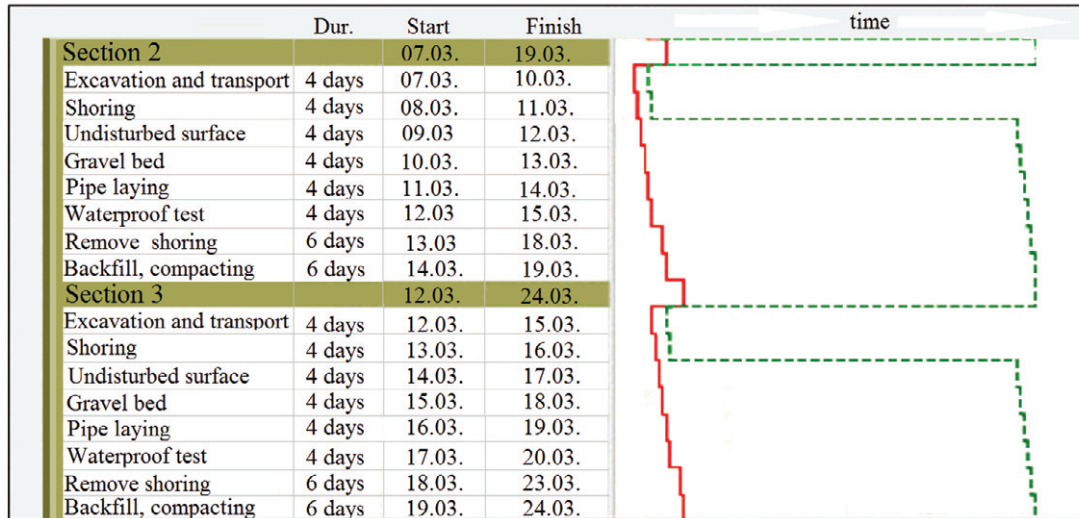


Fig. 1. Revealing the Shortcomings of Planning

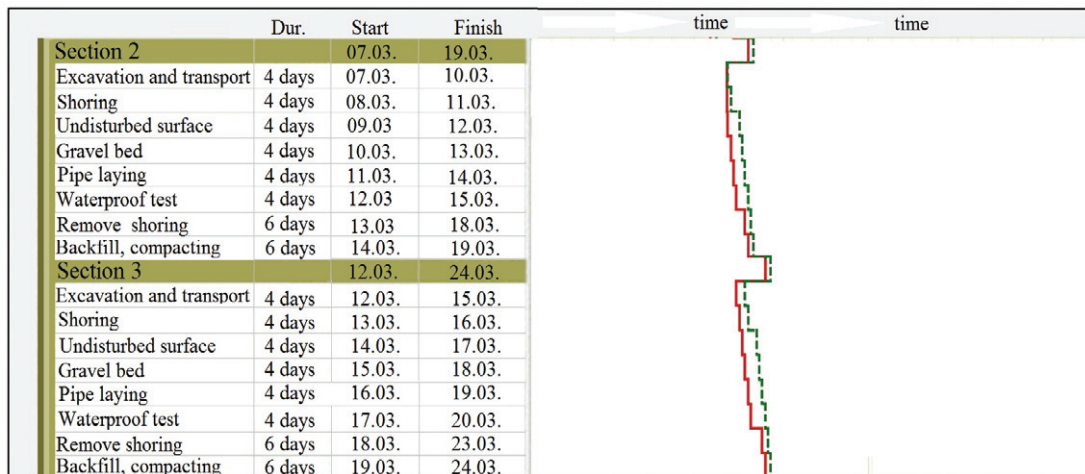


Fig. 2. The Sample Project of Figure 1 after Modifications

The “Display Date Fields on the Timescale” function of ProJack Manager 2010 has been used in order to create the example above. The sample problem demonstrates that this application is suitable for displaying evaluation lines allowing the analysis of the plan. However, it does not fulfill all – previously mentioned – goals, due to the fact that only date-type data can be displayed.

3.3. Finishes Calculated Based on Various Remaining Duration Estimations

Figure 3 shows a test project with five activities. After surveying the tasks, the scheduled finishes are determined based on different types of remaining duration estimations.

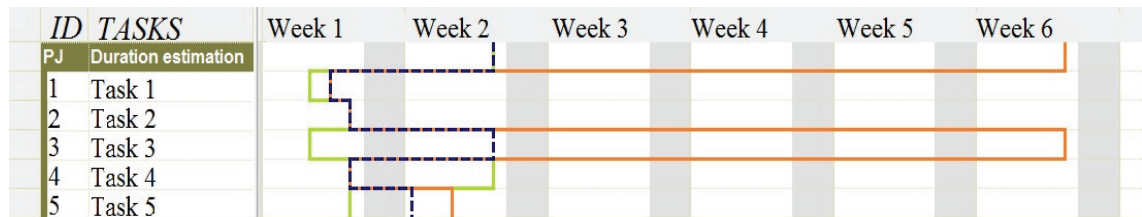


Fig. 3: Scheduled finishes according to different remaining duration estimations

Three evaluation lines are plotted on Figure 3:

- green: originally scheduled finishes,
- blue: finishes calculated based on interrupted remaining duration estimation.,
- maroon: finishes calculated based on continuous remaining duration estimation.

3.4. Information on Actual Costs

In the next example the cost data of the activities are going to be analyzed. Figure 4 shows the ACWP, BCWP and BCWS values of the tasks of the previously mentioned sewage system construction project on a given day.

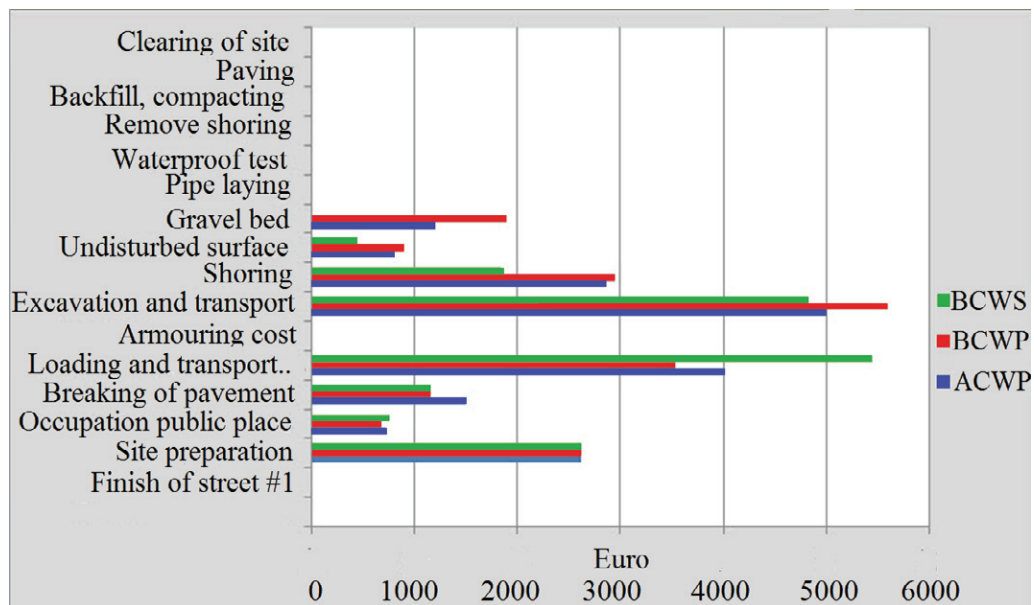


Fig. 4: Cost Data of the Activities

The analysis is worth being performed by comparing the three values to each other:

- $ACWP > BCWP > BCWS$ – if the task is going to be carried out with the same intensity, it could be finished before the scheduled date, however, cost overrun is expected.
- $BCWS > BCWP > ACWP$ – if the task is going to be carried out with the same intensity, it may be finished after the scheduled date, however, cost saving is expected.
- $ACWP > BCWS > BCWP$ – if the task is going to be carried out with the same intensity, it may be finished after the scheduled date, furthermore, cost overrun is expected.
- $BCWP > BCWS > ACWP$ – if the task is going to be carried out with the same intensity, it could be finished before the scheduled date, furthermore, cost saving is expected.
- $BCWP > ACWP > BCWS$ – Both the actual cost and the cost calculated based on the percentage of completion are lower than the budgeted cost. Consequently, if the task is going to be carried out with the same intensity, it could be finished before the scheduled date, furthermore, cost saving is expected.
- $BCWS > ACWP > BCWP$ – Both the actual cost and the cost calculated based on the percentage of completion are higher than the budgeted cost. Consequently, if the task is going to be carried out with the same intensity, it may be finished after the scheduled date, furthermore, cost overrun is expected.

4. Conclusions

In the course of our work, our aim has always been to create a system that makes the full-scale visual display of project data possible. Dozens of evaluation lines in many categories can be defined during the lifetime of the project. They allow us to plan and analyze the data quickly and effectively in all phases of the project.

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